KeyLabs™
Lab Acquisition Corp.

Final Report

Sun ONE and Apache /Tomcat Performance Comparison

Project ID: <u>305015</u>

KeyLabs™

T E S T E D

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1.0   EXECUTIVE SUMMARY

In August of 2003, Sun Microsystems contracted KeyLabs™ to perform an independent performance comparison of the Apache HTTP Server with Tomcat and Sun ONE web server versions 6.0 and 6.1.

The specific objectives of this project were to:

- Measure and report the peak client connections for each configuration

- Determine the effect on web server performance of adding additional processors to the system.

- Determine the response time and number of successful transactions of the web server under load.

1.1   Test Summary

The load level used to calculate the peak performance was the level where the CPU Idle time for all servers was below 10% or 1000 users, which ever came first. Load level data was gathered at user loads of 200, 400, 600, 800, and 1000 users. Data used for comparison is the first set of data points gathered after all servers were below 10% idle.

The table below shows the number of users where the CPU utilization increased above 90% for each product in all configurations. The data shows that the Sun ONE 6.0 and 6.1 servers consistently were able to sustain a larger number of users before the processor utilization increased above 90%. With 1 CPU the Sun ONE 6.0 and 6.1 servers sustained user loads of 20% and 42% greater than the Apache/Tomcat configuration. This pattern continued with 16% and 47% more users at the 2 CPU level increasing to 22% and 52% more users at the 4 CPU level. Once SSL is introduced into the mix, the gap between Sun ONE and Apache/Tomcat increased dramatically with Sun ONE 6.0 sustaining 146% more users and Sun ONE 6.1 sustaining 208% more users than Apache/Tomcat.

Table 1: Actual User Level when CPU Utilization Increased Above 90%

	1 CPU	2 CPU	4 CPU	4 CPU (SSL)
Apache/Tomcat	188	346	656	65
Sun ONE 6.0	226	400	800	160
Sun ONE 6.1	266	507	1000	200

For the 1 CPU configuration the peak user level was four hundred virtual users. The Page Time results (shown in Figure 1 below) at this level showed that the Sun ONE 6.0 web server was 1.6 times faster than Apache while the Sun ONE 6.1 web server was 2.7 times faster.

The peak load level for the 2-processor test was 600 virtual users.   The Page Time results from the two processor test showed Sun ONE 6.0 was 1.8 times faster and Sun ONE 6.1 was 5.1 times faster than Apache.

Finally for the four processor test the maximum or 1000 users represented the peak load level. With 1000 virtual users Sun ONE 6.0 was 2.4 times faster than Apache and Sun ONE 6.1 was 8 times faster than Apache as shown in Figure 1 below.

The most notable difference in page time was with the SSL test. For this test the peak load was 200 users. Sun ONE 6.0 results were 7 times faster than Apache, while Sun ONE 6.1 was 24 times faster.
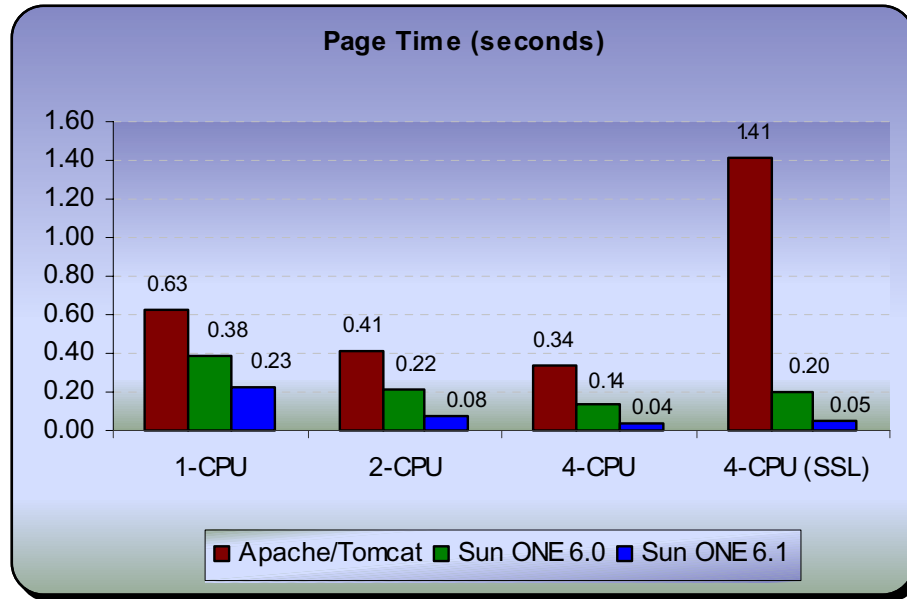

Figure 1: Page Time (seconds)

2.0 TEST METHODOLOGY

For this performance comparison KeyLabs setup a lab environment with one machine used for the RadView's WebLOAD console and 50 additional client machines used to generate load. To insure adequate bandwidth for the tests, the client machines were separated into seven groups. Each group had a 100 Mbit connection to the Cisco 2900 switch, which was connected with a gigabit connection to the test server.

Twelve test runs were conducted to complete the performance test. Each server was tested with one, two and four processors. An additional test using SSL was run on each server using four processors. KeyLabs monitored the CPU utilization of the server to identify the point where the server hardware impacted the overall test performance. Server memory and network bandwidth utilization were also monitored. The monitoring was conducted using vmstat and RadView's WebLOAD Processor Monitor.

Each test ran until the load level reached 1000 users. Two hundred users were added during each ramping cycle. Once the ramp was complete the load level was maintained for 10 minutes.

At the completion of each test KeyLabs established the breaking point, if one was reached. The term "breaking point" is defined as the point at which potential customers are no longer experiencing acceptable performance during their session on the website while attempting to view information or process transactions. For the purpose of this test, the breaking point was defined by any one of the following:

- The Server CPU utilization was over 90%

- 5% of the users failed to connect at any given time, receiving errors such as "Connection refused" or "Connection timed out"

2.1   Website Content

The sample websites used to test each web server consisted of a mix of static and dynamic content. The web pages returned ranging in size from .1k to 1000k. Two different types of dynamic content were used during testing: JSP and a plug-in written to the native API of each Web Server. The same content was used wherever possible; however the native plug-ins utilized the Apache API on the Apache server and the NSAPI on the Sun ONE servers.

2.2   Test Script Description

The test scripts create load distributed between static and dynamic content as defined in the table below. Most of the pages requested by the script were 10k or smaller in size. However, the script also requested a small percentage of files in the upper and lower extremes of the available size range. The same distribution of page sizes was requested on each web server. The scripts also used a combination of gets and posts and maintained a ½ second wait time between each request.

**Table 2: Percentage Requested of Each Content Type**

| Content Type	Percentage of Overall Load
Static content	70
JSP	20
C	10

3.0   HARDWARE & SOFTWARE CONFIGURATION

The test lab was configured using standard CAT-5 cabling on a 100base-TX infrastructure from the clients to Intel Express 460T 10/100 full-duplex switches. These switches were connected using CAT-5 cabling to a Cisco 6500 switch. The server was connected to the Cisco 6500 switch by gigabit copper Ethernet. All clients were "clean" configured with Windows 2000 Professional, with the latest service pack. Default software settings were used.

Dell OptiPlex PIII 600 machines were used for the load generator computers. Each workstation was connected to an Intel Express 460T switch with 7 or 8 workstations per switch. The Intel switches were then connected to a Cisco 6500 switch.

Figure 2: Test Configuration of Apache Http Server
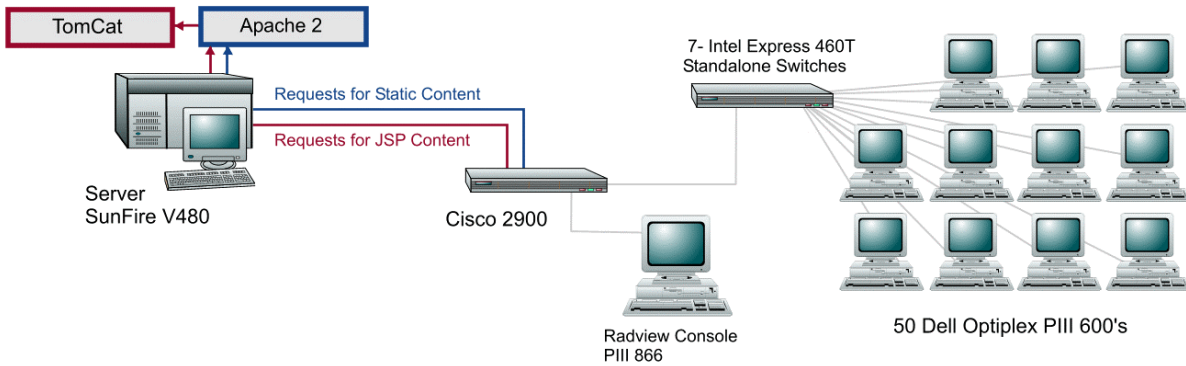
Figure 3: Test Configuration of Sun ONE Web Servers
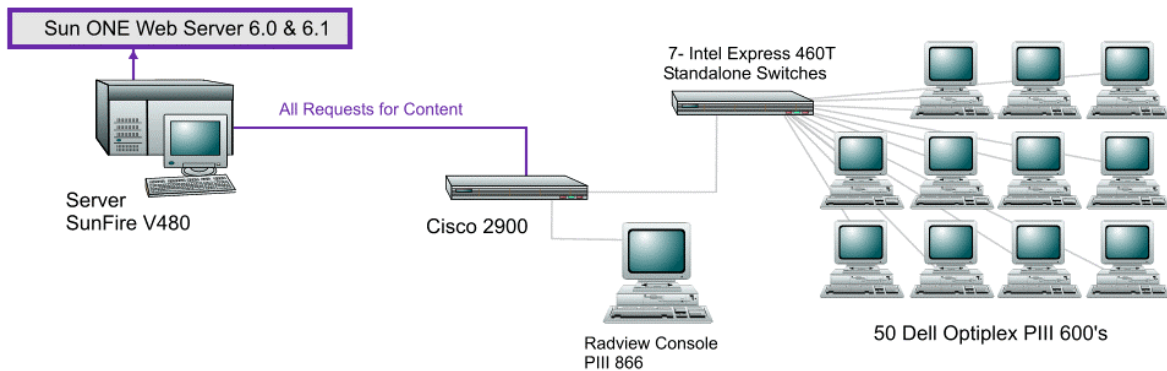
3.1   Hardware Configurations

Server

- Model: Sun Sunfire 480
- CPU: Four 1.05 GHz UltraSPARC III Cu processors
- Memory: 8 GB RAM
- HD: Two FC-AL disks, 235 GB
- NIC: Two integrated dual 10/100/1000 Mbps Ethernet ports
- Operating System: Solaris 9 SPARC, (with Recommended Solaris Patch Clusters)
- Java 2 SDK, Standard Edition (J2SE), v 1.4.1_03

RadView Console

- CPU: PIII 866 MHz
- Memory: 512 MB RAM
- HD: ≥ 9 GB IDE
- NIC: 3Com EtherLink 10/100 PCI NIC (3C905C-TX)

- Operating System: Microsoft Windows 2000 Professional w/SP3
- Microsoft Internet Explorer 6.0 w/SP1
- RadView WebLOAD Console version 5.0.226.00

Load Generators

- CPU: Pentium III 600MHz

- Memory: 256 MB RAM

- NIC: Intel PRO/100+

- HD: ≥ 9 GB IDE

- Operating System: Microsoft Windows 2000 Professional w/SP3

- Microsoft Internet Explorer 6.0 w/SP1

- RadView WebLOAD Load Generating Component version 5.0.226.00

3.2   Web Server Configuration

3.2.1   Apache /Tomcat

For this test KeyLabs used Apache 2 and Tomcat 4.1.24. The Apache web server was configured with the Coyote connector. During the test all request were directed to the Apache web server, which then routed only the JSP requests to Tomcat.   When the Apache server was compiled SSL enabled, and the worker mpm was specified. Tomcat used the Sun Java version 1.4.1_03.

3.2.2   Sun ONE

Two versions of the Sun ONE server were used during testing; Version 6.0 and version 6.1. Both servers used the Sun Java version 1.4.1_03.

4.0   PERFORMANCE DATA

During the tests data was gathered at 200, 400, 600, 800, and 1000 users. The tables below display the overall Page Time, Hits Per Second, Successful Rounds, and CPU Idle time averages at the various user load levels.

Table 3: Overall Test Result Averages – 1 CPU

	Page Time		Hits Per Second		Successful rounds		CPU: Idle	
User Level	200	400	200	400	200	400	200	400
Apache/ Tomcat	0.052	0.627	424.697	420.42	3562.2	3525.0	7.2	0.2
Sun ONE 6.0	0.031	0.384	440.292	531.49	3696.3	4461.4	18.9	1.5
Sun ONE 6.1	0.031	0.229	439.268	640.41	3693.2	5376.2	35.4	5.6

Table 4: Overall Test Result Averages – 2 CPU

	Page Time		Hits Per Second		Successful rounds		CPU: Idle	
User Level	400	600	400	600	400	600	400	600
Apache/ Tomcat	.090	.409	779.6	767.8	6548.9	6451.4	3.2	2.2
Sun ONE 6.0	.025	.217	870.1	961.2	7299.2	8069.1	12.9	2.7
Sun ONE 6.1	.016	.079	883.5	1169.7	7394.5	9798.0	29.9	5.9

Table 5: Overall Test Result Averages – 4 CPU

	Page Time		Hits Per Second		Successful rounds		CPU: Idle	
User Level	800	1000	800	1000	800	1000	800	1000
Apache/ Tomcat	.184	.337	1314.1	1344.4	11019.2	11276.7	7.0	5.6
Sun ONE 6.0	.048	.138	1590.2	1713.3	13330.2	14370.7	14.8	6.2
Sun ONE 6.1	.020	.042	1656.8	1942.2	13889.2	16287.7	29.6	16.0

Table 6: Overall SSL Test Result Averages – 4 CPU

	Page Time		Hits Per Second		Successful rounds		CPU: Idle	
User Level	200	400	200	400	200	400	200	400
Apache/ Tomcat	1.414	3.346	124.0	123.6	1038.1	1033.3	1.5	1.5
Sun ONE 6.0	.202	1.072	333.9	302.17	2812.8	2540.8	.7	.2
Sun ONE 6.1	.058	.541	418.6	451.3	3516.2	3788.3	7.0	1.4

5.0   PAGE TIME COMPARED TO USER LOAD SIZE

Page time represents the time it takes to load all the elements on a page.   The time for each element includes Connect Time, Send Time, Response Time, and Process Time. The value listed is the page time average for a given user level. The Page Time should stay level or increase slightly as the number of users is increased. Dramatic increases indicate some kind of bottleneck or threshold is being reached.

The graphs below show an increasing page time matching the increasing load on the servers. However, performance thresholds were not exceeded during the Sun ONE 6.1 4 CPU test where the page time increases only slightly throughout the duration of the test. Below are the averages for each configuration for the duration of the entire testing period.
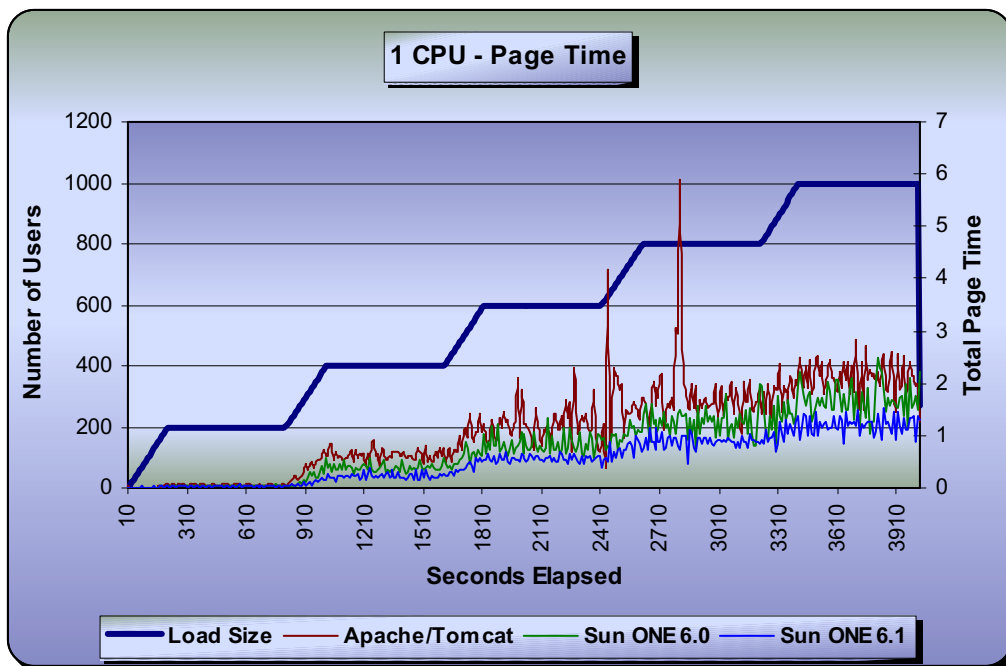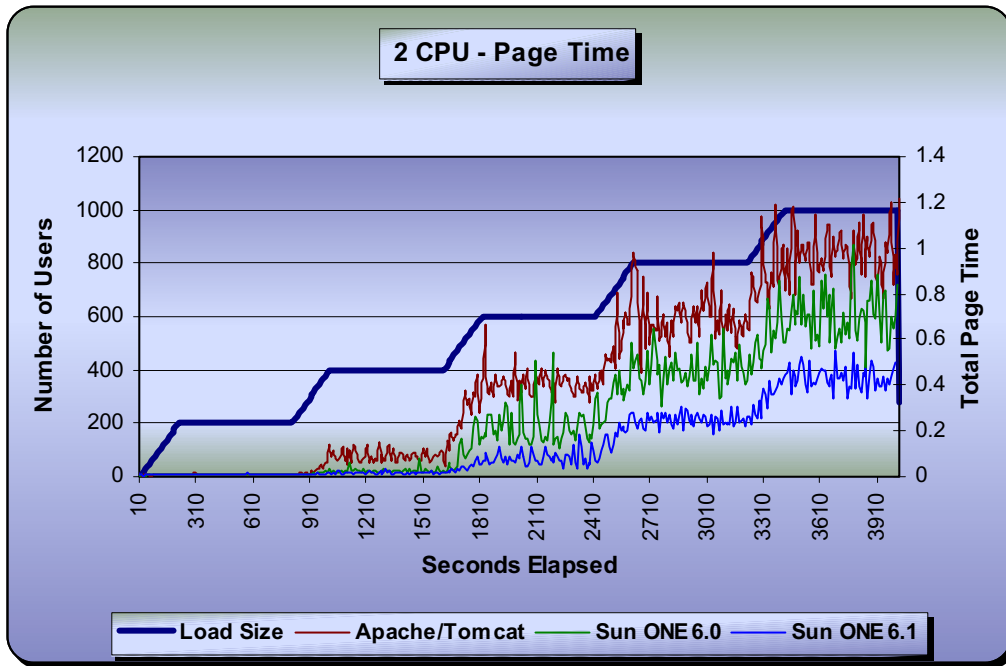

Figure 4: 1 CPU - Page Time
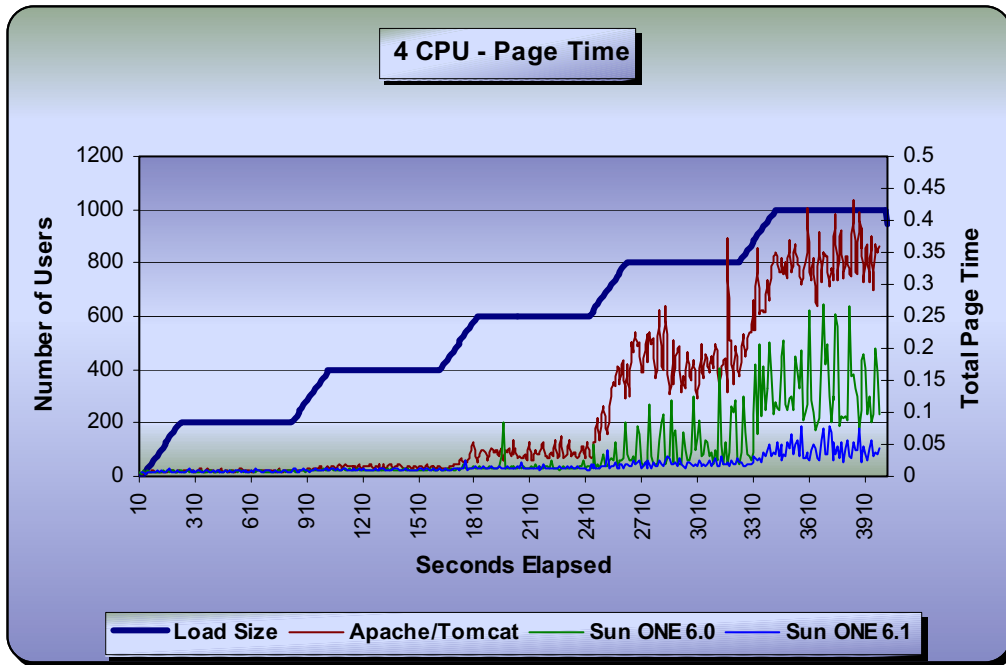
Figure 5: 2 CPU - Page Time

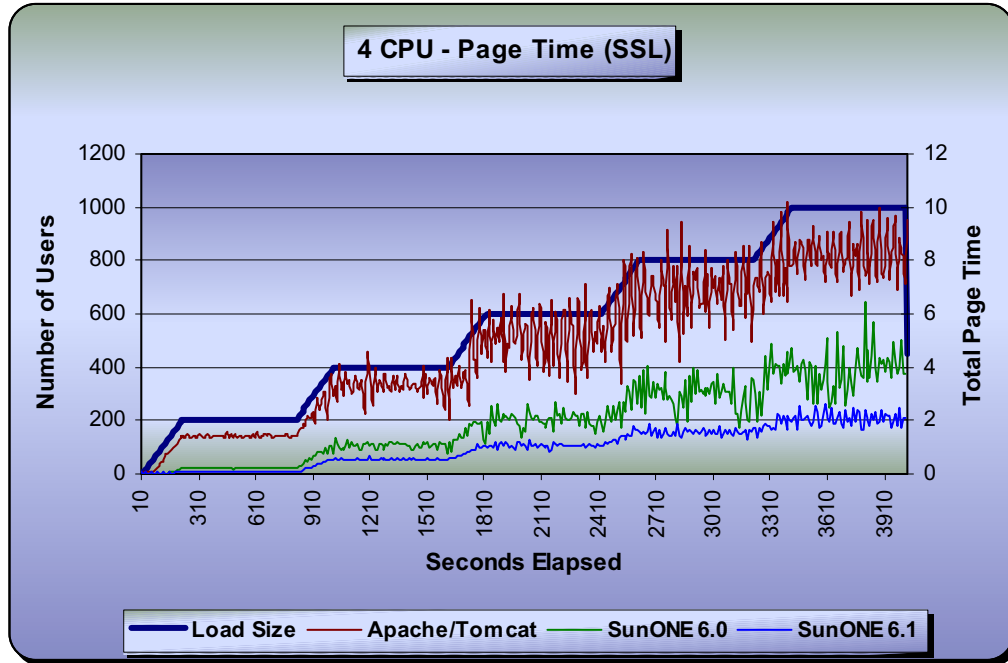**Figure 6: 4 CPU - Page Time**

Figure 7: 4 CPU - Page Time (SSL)

6.0   HITS PER SECOND COMPARED TO USER LOAD SIZE

Hits Per Second represent the number of transactions (such as a Get or Post) submitted to the website, divided by the elapsed time (in seconds). Each element of a page (such as a graphic) generates its own Get or Post. For example, if a page contains 3 graphics, the number of transactions would be 4 (1 transaction to get the actual page and 1 for each of the 3 graphics). This means that a single HTML page could generate any number of transactions depending on its content. As a general rule, the number of Transactions or Hits Per Second should increase as the number of users increase. The major indicator that a website is reaching its limit is if the number of Transactions or Hits Per Second stops increasing or decreases as the number of users increases.

The graphs below show that during most tests the performance threshold was reached.   The hits per second do not increase as additional load is added to the server.
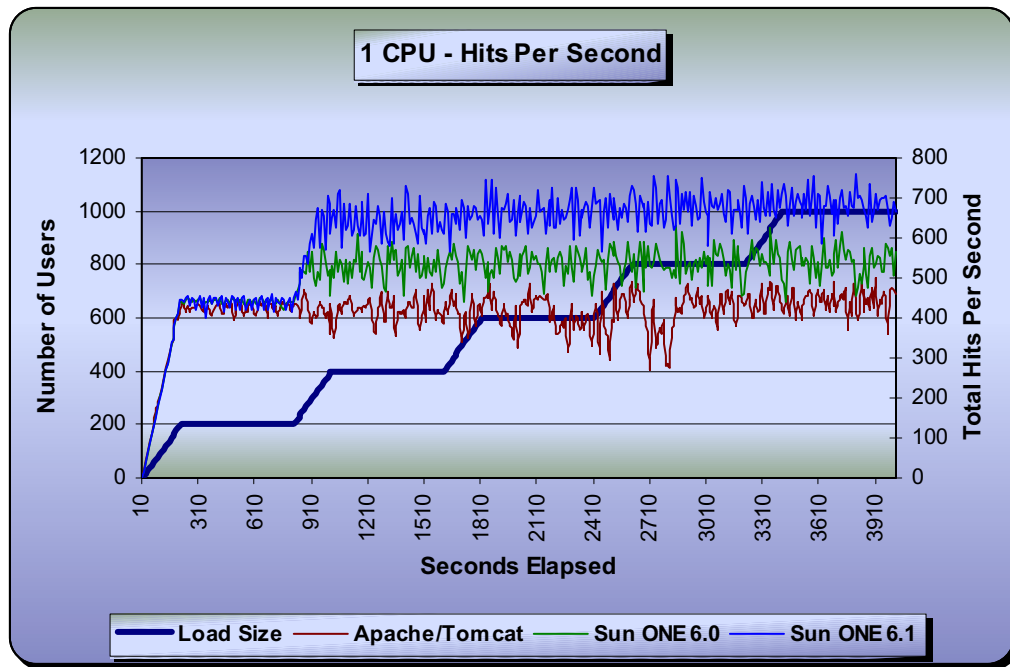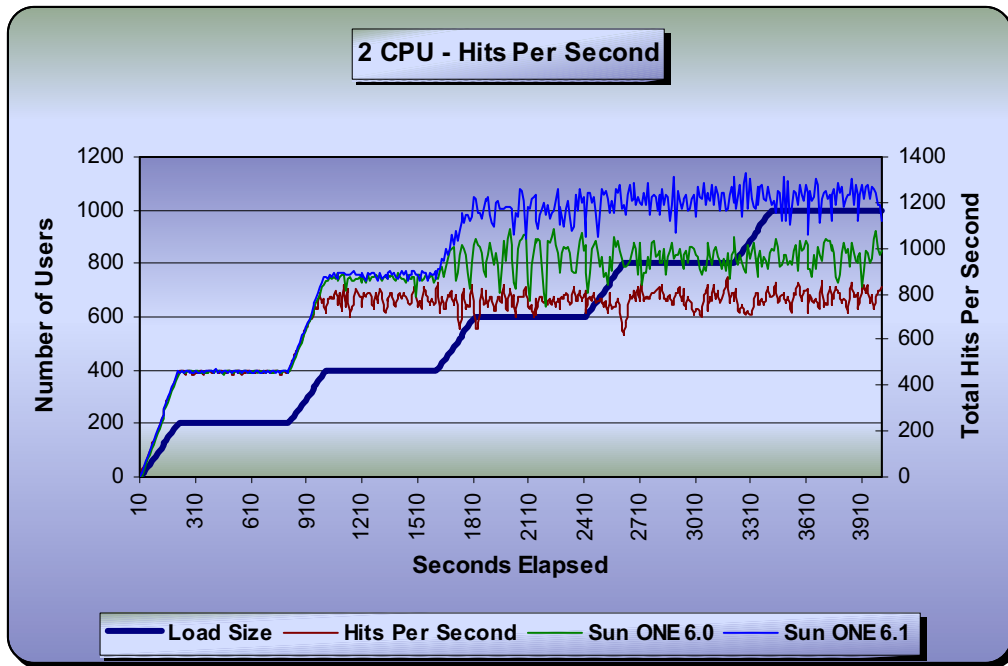

Figure 8: 1 CPU - Hits Per Second

2 CPU - Hits Per Second

Figure 9: 2 CPU - Hits Per Second
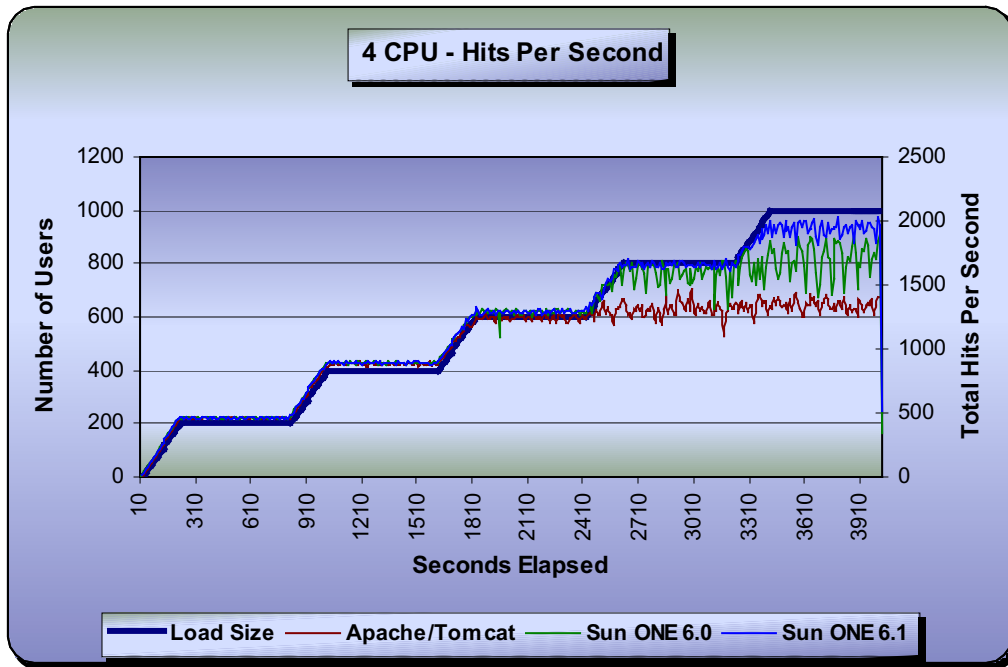
4 CPU - Hits Per Second
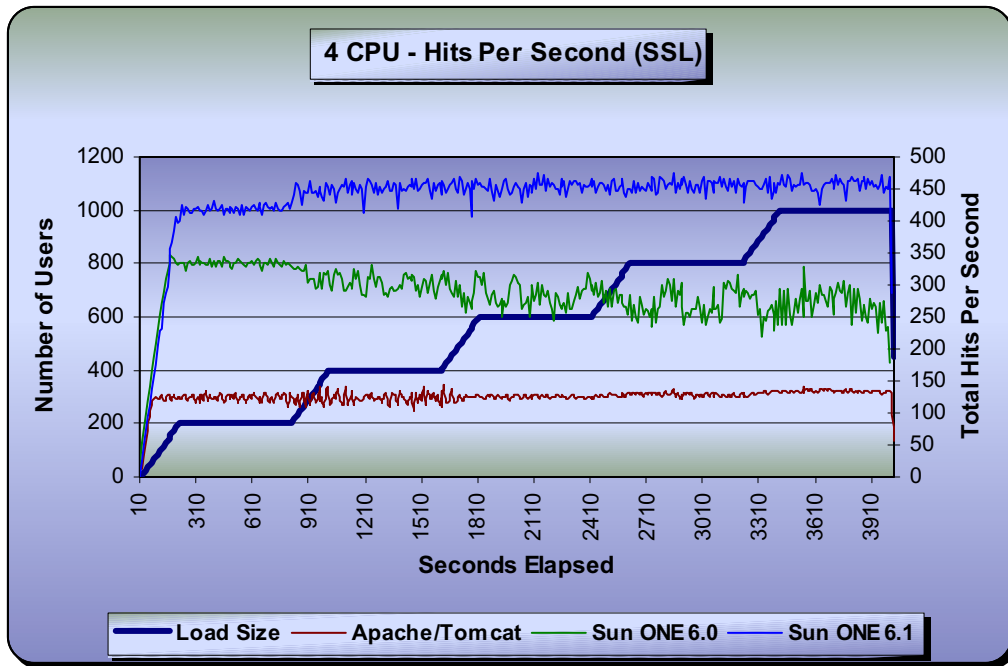
Figure 10: 4 CPU - Hits Per Second

Figure 11: 4 CPU - Hits Per Second (SSL)

7.0 SUCCESSFUL ROUNDS TO USER LOAD SIZE

Successful Rounds is defined as the total number of times the users complete one iteration of the script during a specific reporting interval. Each iteration of the script consisted of a Get or Post on a single page. During the test, a 10-second reporting interval was used for gathering statistics. As a general rule, the number of Successful Rounds should increase as the number of users increases. If the number of Successful Rounds does not increase or decreases with user level increase, this indicates that a threshold has been reached resulting in either the page load time slowing down or the number of failures increasing.

The graphs below show that on most tests a threshold was reached, as the number of Successful Rounds did not continue to rise when user load was increased. On all tests Apache/Tomcat reached its saturation point before Sun ONE 6.0 and 6.1. Also apparent is the improvement of Sun ONE 6.1 over Sun ONE 6.0, as Sun ONE 6.1 is able to sustain higher Successful Round numbers than its predecessor.
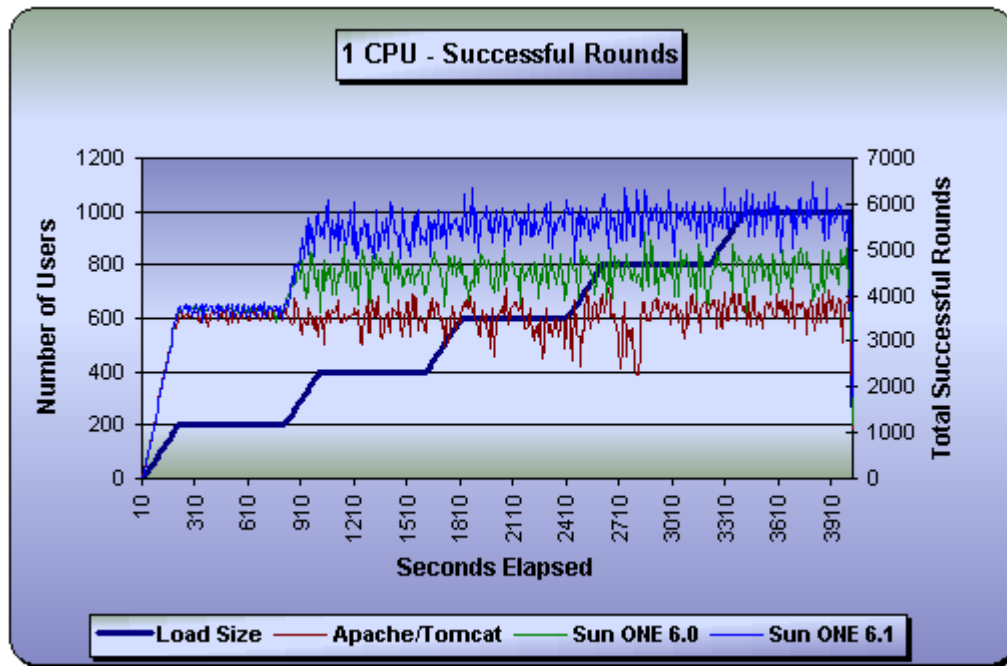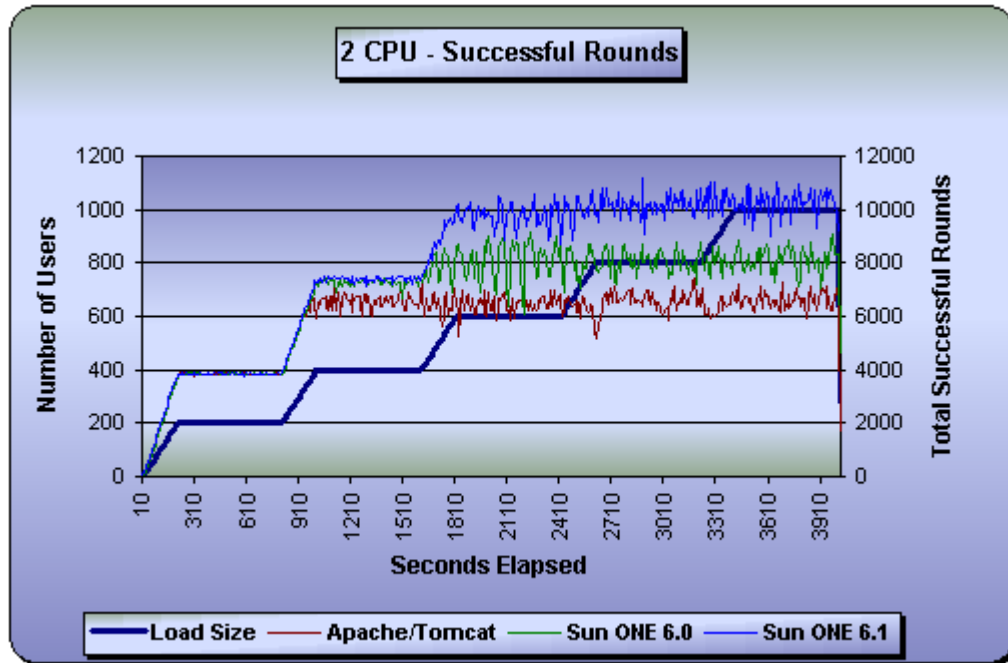

Figure 12: 1 CPU – Successful Rounds

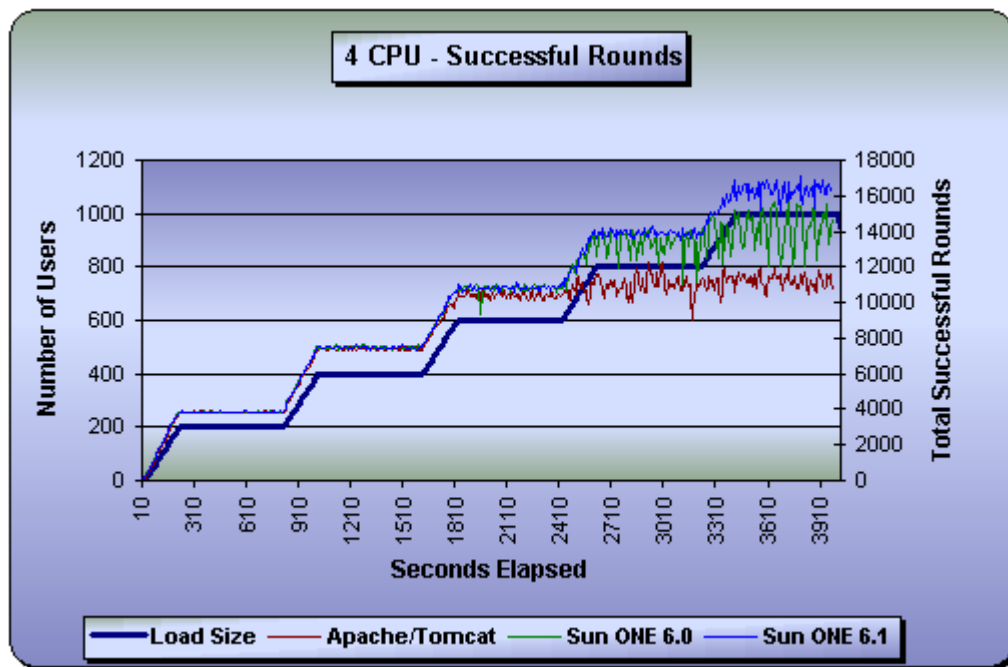**Figure 13: 2 CPU – Successful Rounds**
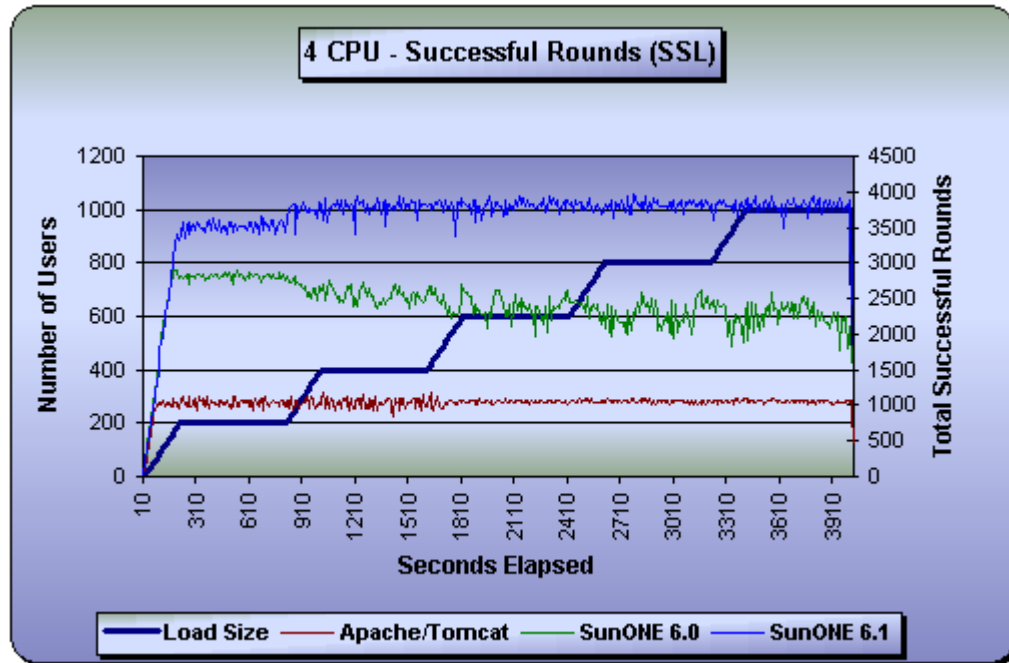

Figure 14: 4 CPU – Successful Rounds

Figure 15: 4 CPU – Successful Rounds (SSL)

8.0 CPU IDLE COMPARED TO USER LOAD SIZE

CPU Idle represents the percentage of the CPU that remains idle, and inversely the CPU activity during the test run. In the tests where multiple processors were used, this number represents the average idle time for all available CPUs.

The graphs below show the CPU utilization during the test scenarios. In our test scenarios we selected a break point of less than 10% idle. At this point the system lacks the CPU resources to keep up with the number of processes scheduled for run time. CPU utilization did represent a limiting factor in all but one test scenario. During the 4CPU test of the Sun ONE 6.1 web server at 1000 users the CPU idle was 16%. This indicates that under our test conditions, with 4 CPUs Sun ONE 6.1 should be able to process requests from over 1000 users.
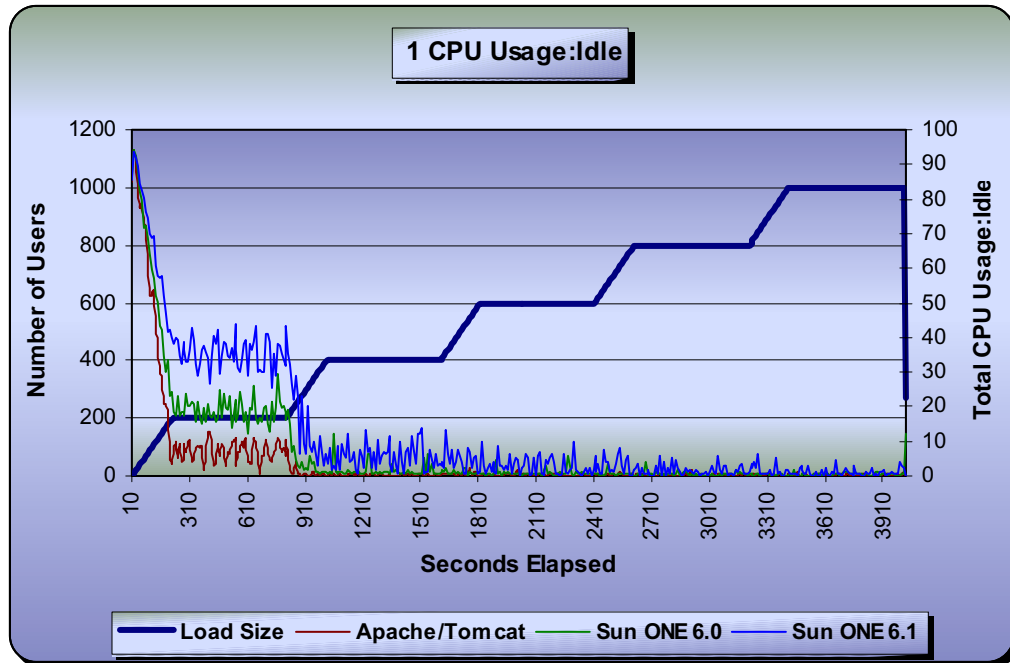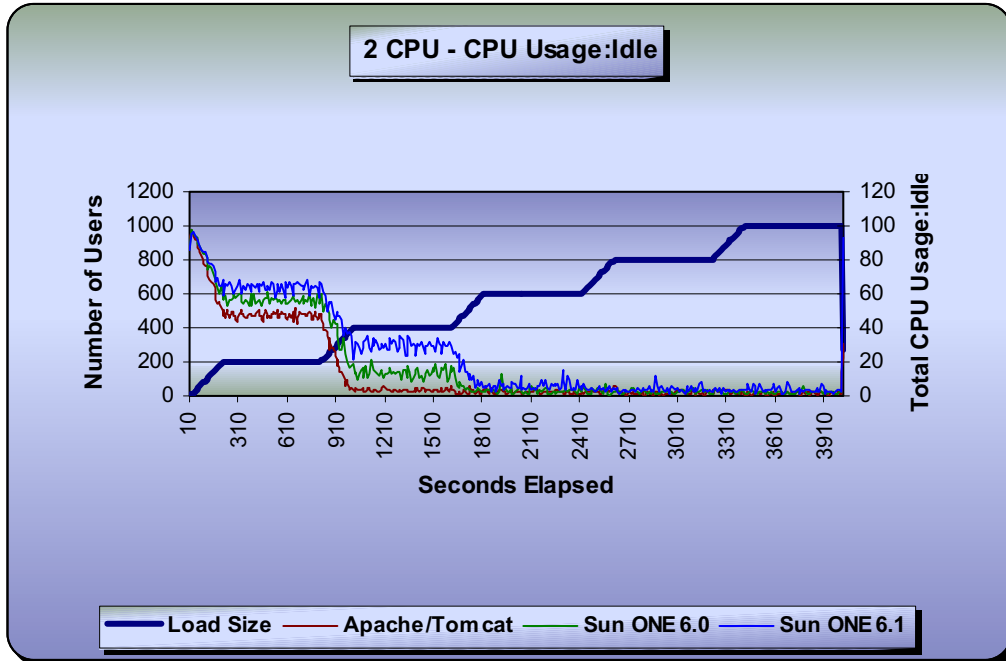

Figure 16: 1 CPU Usage: Idle
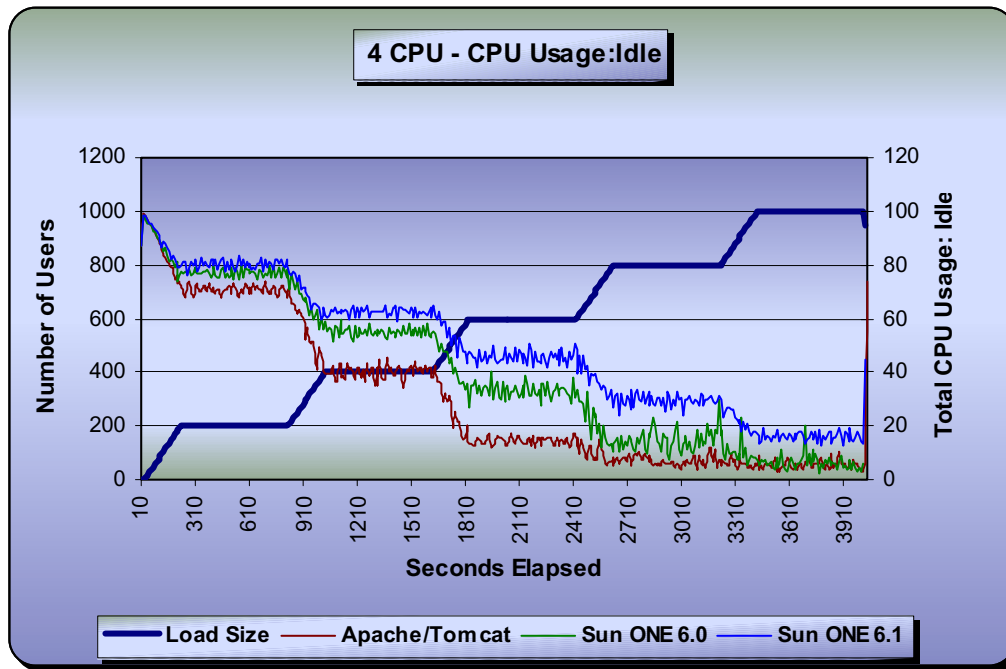
Figure 17: 2 CPU Usage: Idle

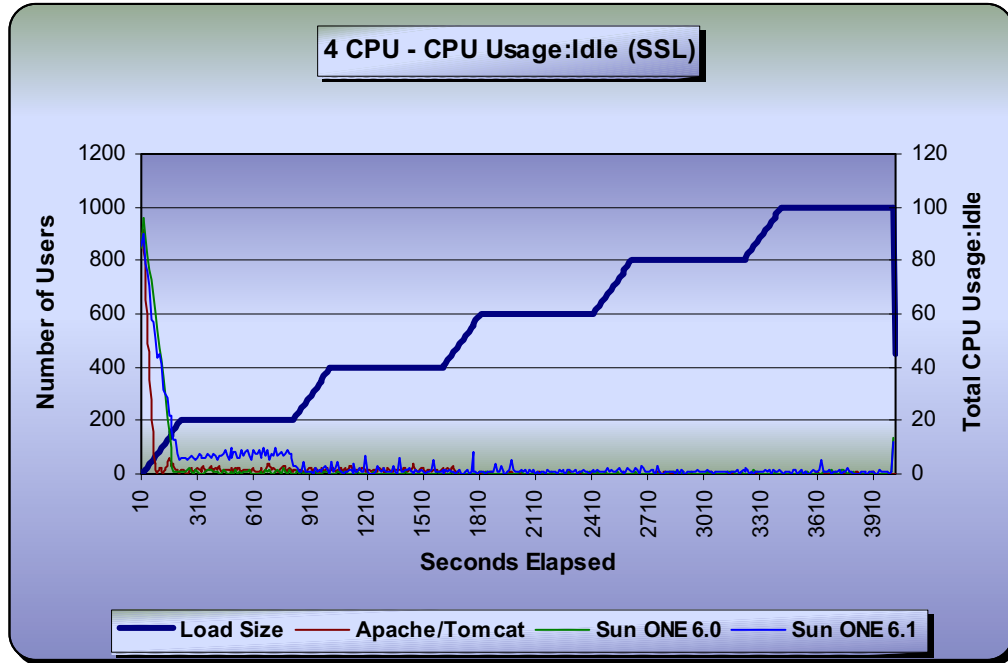**Figure 18: 4 CPU Usage: Idle**

Figure 19: 4 CPU - Usage: Idle (SSL)

9.0   ERRORS

When a site begins to reach its maximum sustainable load level, it is common for the clients to receive errors from the server. These usually reveal themselves as connection refused or connection time out errors. In rare cases a 500 Server level error did occur.

Throughout the entire testing period, only two test runs reached an error level of 5%. These test runs were the Apache/Tomcat 1CPU test and the Apache/Tomcat 4CPU SSL test. The Apache/Tomcat 1CPU test reached a 5% error level at 866 users, while the Apache/Tomcat 4CPU SSL test showed 5% errors at 800 users. In both cases, the 5% error level occurred well beyond the point that the CPU was 90% utilized. With the exception of the 1000 user level Apache/Tomcat test, the overall average error percentage for all products, configurations and user levels remained under 5%.

The Apache/ Tomcat configuration did not respond as well to rapidly increasing load level, as the Sun ONE servers. Both Sun ONE 6.0 and Sun ONE 6.1 could be loaded with up to 500 users at a time with no errors returned. The Apache/Tomcat configuration would return errors when loading 200 users at a time.

Table 7: Average Error Percentage

Average Error Percentage						
Users		**200**	**400**	**600**	**800**	**1000**
1 CPU	**Apache/Tomcat**	0.005%	0.082%	0.628%	1.304%	3.182%
	Sun ONE 6.0	0.000%	0.021%	0.205%	0.574%	1.192%
	Sun ONE 6.1	0.000%	0.000%	0.115%	0.458%	0.954%
2 CPU	**Apache/Tomcat**	0.000%	0.006%	0.058%	0.418%	0.941%
	Sun ONE 6.0	0.000%	0.000%	0.009%	0.031%	0.210%
	Sun ONE 6.1	0.000%	0.000%	0.000%	0.011%	0.079%
4 CPU	**Apache/Tomcat**	0.000%	0.000%	0.002%	0.010%	0.054%
	Sun ONE 6.0	0.000%	0.000%	0.000%	0.000%	0.001%
	Sun ONE 6.1	0.000%	0.000%	0.000%	0.000%	0.000%
4 CPU (SSL)	**Apache/Tomcat**	0.003%	0.002%	0.000%	3.006%	8.007%
	Sun ONE 6.0	0.000%	0.000%	0.000%	0.000%	0.000%
	Sun ONE 6.1	0.000%	0.000%	0.077%	0.437%	1.170%

The following table shows the user level at which the first error was received. In all cases Sun ONE 6.0 and 6.1 were able to sustain a larger number of users before receiving an error when compared to Apache/Tomcat. With the 1 CPU test Sun ONE 6.0 and 6.1 sustained 100% and 163% more users than Apache/Tomcat. With the 2 CPU test this pattern continued with Sun ONE 6.0 sustaining 69% and Sun ONE 6.1 sustaining 118% more users than Apache/Tomcat. At the 4 CPU level Sun ONE 6.0 sustained 67% more users than Apache/Tomcat and Sun ONE 6.1 did not receive a single error during the test duration. With the SSL test, Sun ONE 6.0 platform did not receive errors, and Sun ONE 6.1 was able to sustain 141% more users than Apache/Tomcat before an error was received.

Table 8: User Level of First Failed Round

	1 CPU	2 CPU	4 CPU	4 CPU (SSL)
Apache/Tomcat	200	356	600	200
Sun ONE 6.0	400	600	1000	*
Sun ONE 6.1	526	777	*	481

* No errors were returned during the test.

10.0 CONTRIBUTING PARTNERS

This section of the report contains a list of KeyLabs partners who have provided resources used for this project.

LabExpert® is a fully automated software installation and configuration management solution for PC labs and classrooms. http://www.altiris.com

WebLOAD® is a fully licensed software package of RadView. Information about the test suite can be found at the RadView website at http://www.radview.com.